An Application for High Availability NOMADS

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where the nation's climate and weather services begin

NOAA Operational Model Archive and Distribution System (NOMADS)

Designed to provide real-time and retrospective format independent access to climate, ocean and weather model data, and advance the integration of real time model data and applications responding to strategic guidance and NOAA's role:

- ✓ A digital archive of NOAA's operational weather models, and an "innovative data access philosophy to promote interoperable access across the geosciences" (*BAMS, Rutledge et. al., 2006)*
- ✓ **The real time data service is now on a high availability server at the NOAA Web Operations Center (WOC)**
- ✓ An integrator of common web services infrastructure to support the discovery, access and transport of data (*NOAA GEO-IDE Concept of Operations Rept. to the DMC, 2005*).
- ✓ "Completing the Forecast" (NRC, 2006) Recommendation 3.4: "*NOMADS should be maintained and extended to include: (a) long-term archives of the global and regional* ***Ensemble*** *forecasting systems at their native resolution, and (b) re-forecast datasets to facilitate post-processing."*
- ✓ The NOAA FY07-11 Baseline Assessment (pp10) points out that there is a "…*pressing need for enhancement to present capabilities needs through: improving capabilities to process and disseminate increasing volumes of environmental data."*
- ✓ Recommendation 5 of the National Research Council's (2002) Fair Weather: Effective Partnerships in Weather and Climate Services states: "*The National Weather Service should make its data and products available in accessible digital form*".

NOMADS: High availability servers from different locations using the same protocol to distribute model data.

- Archives of model and other data at the National Climate Data Center (NCDC) NOMADS (Separate Operations Implemented in 2007)
- National Center's for Environmental Prediction (NCEP) real time model data from NOAA's Operational Models
- Other agencies use the same protocol to distribute environmental data, eg., GFDL, PMEL, NCAR, NASA… and collaborate through organizations like DMIT, GO-ESSP,…
- NOMADS open source services GDS/OPeNDAP(DODS): http access fast/partial ftp, ftp2/4u ("GRIB filter"), slice, dice and area subset repackaged grib files, pdisp ("Great Displays") development side display program example, and other applications. (see Alpert and Wang, 2004)

- *Goal: All the model data from NCEP Operations*

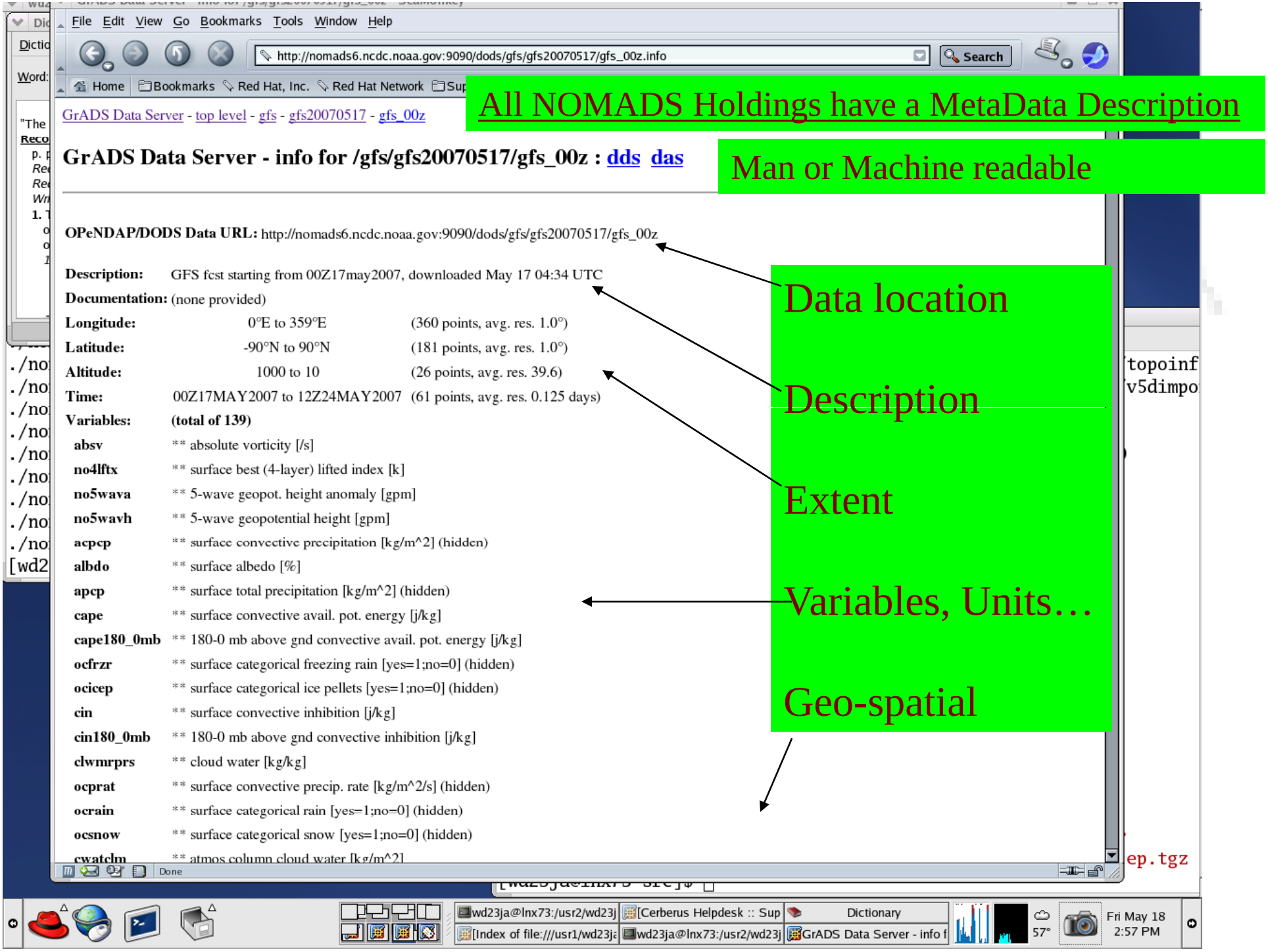
NOAA Web Operations Center (WOC)
NOMADS Commitment (Beginning Feb 15, 2009)

- ✓ NOAA has committed that the Web Operations Center (WOC) is high availability, 24/7 operations
- ✓ NCEP Central Operations (NCO) is committed to the data flow aspect of NOMADS for data to be present and on time from their Operational super computers.
- ✓ NOAA WOC has committed to maintain NOMADS servers now and into the future, as well as day to day operations with costs shared by NOAA and NCEP base
- ✓ A development commitment continues at NCEP Environmental Modeling Center (EMC), a development division, to keep up with new data sets and create applications
- ✓ Data review groups, official committees and procedures for moving new data sets and applications from development to operations follows the existing NCEP Central Operations framework.

The GrADS-Data Server (GDS) OPeNDAP(DODS):

Open Source

- NOMADS participants serve their data sets through a client-server relationship. The data sets have machine and man readable metadata descriptions.
- Display is done by the client.
- GDS combines both GrADS, a freeware client (from COLA) and DODS (OPeN-DAP) server to unpack, cache and exchange data from many formats using http.
- **This means that server data can appear to the user or client application as a local file!**
- DODS requests are made by many freeware and commercial high level language clients like GrADS and MATLAB.
- *http queries to the DODS server can create value added products.*


File Edit View Go Bookmarks Tools Window Help
http://nomads6.ncdc.noaa.gov:9090/dods/gfs/gfs20070517/gfs_00z.info
Search
Home Bookmarks Red Hat, Inc. Red Hat Network
All NOMADS Holdings have a MetaData Description
Man or Machine readable
GrADS Data Server - top level - gfs - gfs20070517 - gfs_00z
GrADS Data Server - info for /gfs/gfs20070517/gfs_00z : dds das
OPeNDAP/DODS Data URL: http://nomads6.ncdc.noaa.gov:9090/dods/gfs/gfs20070517/gfs_00z
Description: GFS fcst starting from 00Z17may2007, downloaded May 17 04:34 UTC
Documentation: (none provided)
Longitude: 0°E to 359°E (360 points, avg. res. 1.0°)
Latitude: -90°N to 90°N (181 points, avg. res. 1.0°)
Altitude: 1000 to 10 (26 points, avg. res. 39.6)
Time: 00Z17MAY2007 to 12Z24MAY2007 (61 points, avg. res. 0.125 days)
Variables: (total of 139)
absv ** absolute vorticity [/s]
no4lftx ** surface best (4-layer) lifted index [k]
no5wava ** 5-wave geopot. height anomaly [gpm]
no5wavh ** 5-wave geopotential height [gpm]
acpcp ** surface convective precipitation [kg/m^2] (hidden)
albdo ** surface albedo [%]
apcp ** surface total precipitation [kg/m^2] (hidden)
cape ** surface convective avail. pot. energy [j/kg]
cape180_0mb ** 180-0 mb above gnd convective avail. pot. energy [j/kg]
ocfrzr ** surface categorical freezing rain [yes=1;no=0] (hidden)
ocicep ** surface categorical ice pellets [yes=1;no=0] (hidden)
cin ** surface convective inhibition [j/kg]
cin180_0mb ** 180-0 mb above gnd convective inhibition [j/kg]
clwmrprs ** cloud water [kg/kg]
ocprat ** surface convective precip. rate [kg/m^2/s] (hidden)
ocrain ** surface categorical rain [yes=1;no=0] (hidden)
ocsnow ** surface categorical snow [yes=1;no=0] (hidden)
cwatclm ** atmos column cloud water [kg/m^2]
Done
Data location
Description
Extent
Variables, Units…
Geo-spatial
wd23ja@lnx73:/usr2/wd23j
[Cerberus Helpdesk :: Sup
Dictionary
[Index of file:///usr1/wd23ja
wd23ja@lnx73:/usr2/wd23j
GrADS Data Server - info f
57°
Fri May 18
2:57 PM

Using http queries (URLs) to extract data from the GDS server
Example: Global Ensemble data set

…DODS/OPenDAP/GDS constrained query:

http://nomads.ncep.noaa.gov:9090/dods/gens/gens20090501/gep_all_00z.ascii?tmpprs[0:19][0:21][1:1][129:129][243:243]

Notice the 5-Dimensional query for each variable (6D), e.g, temperature (tmpprs):

i^{th} Ensemble component	[0:19]	Lists all 20 Ensemble components at,
Forecast times	[0:21]	IC and every 6-hour interval to 5-days is indicated,
Vertical levels	[1:1]	975Mb indicated, and [0:0] would mean 1000mb,
Latitude,	[129:129]	is measured from SP (0) to NP (for a 1 degree grid)
Longitude,	[243:243]	Beginning at the 0 meridian – we show Baltimore Intl

These comprise the ordering of the square bracketed values:
[Ens1:Ens2][Fcst1:Fcst2][lev1:lev2][lat1:lat2][lon1:lon2]

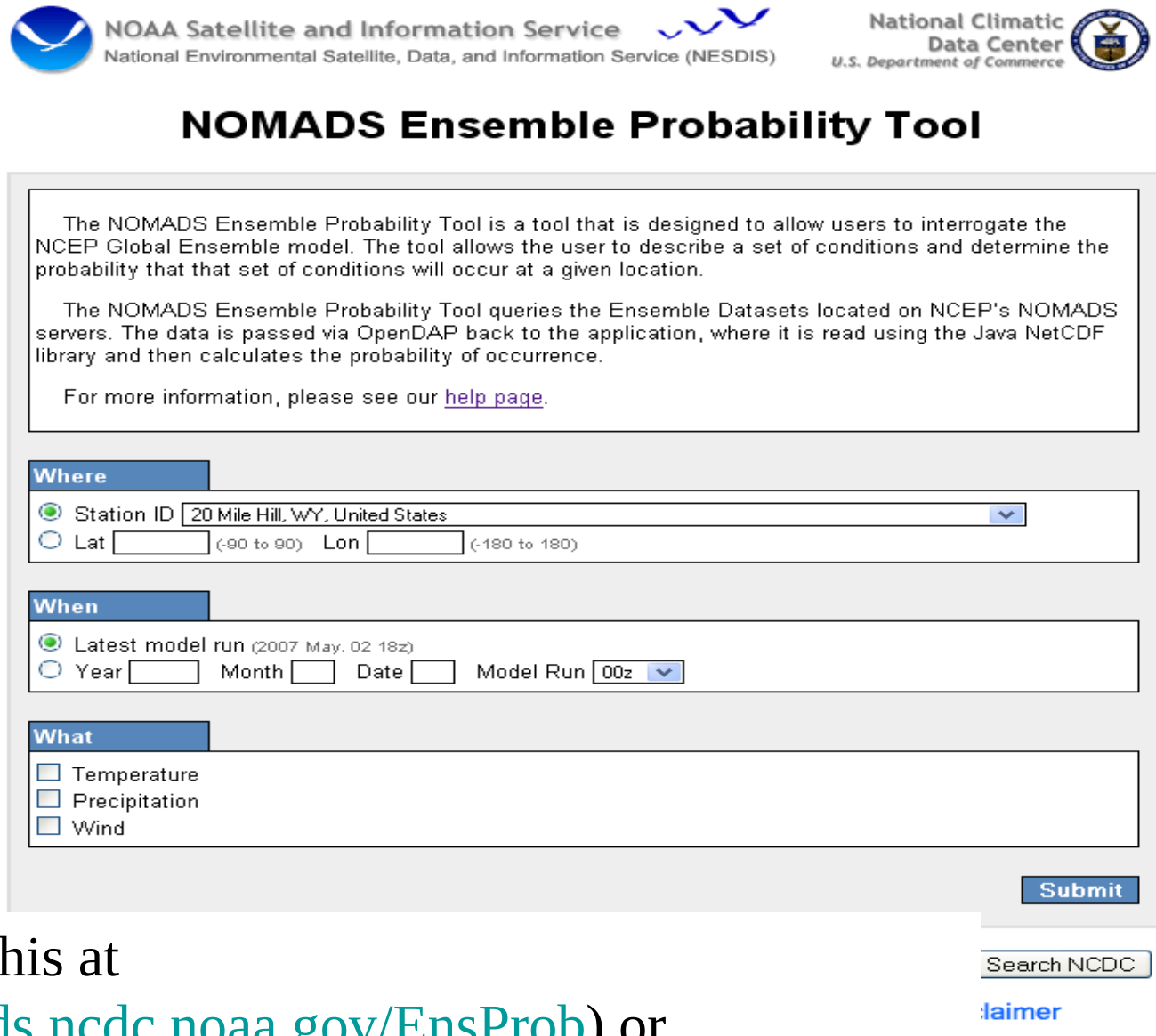
Units and other information represented in the metadata descriptor file and a stride is also possible [start:stride:finish] using colon separated values

Use a non-interactive web download program like “wget” or cURL, and place the URL in cron scheduler and a cgi-bin script to provide user interaction to get or create information or create customized data flow.

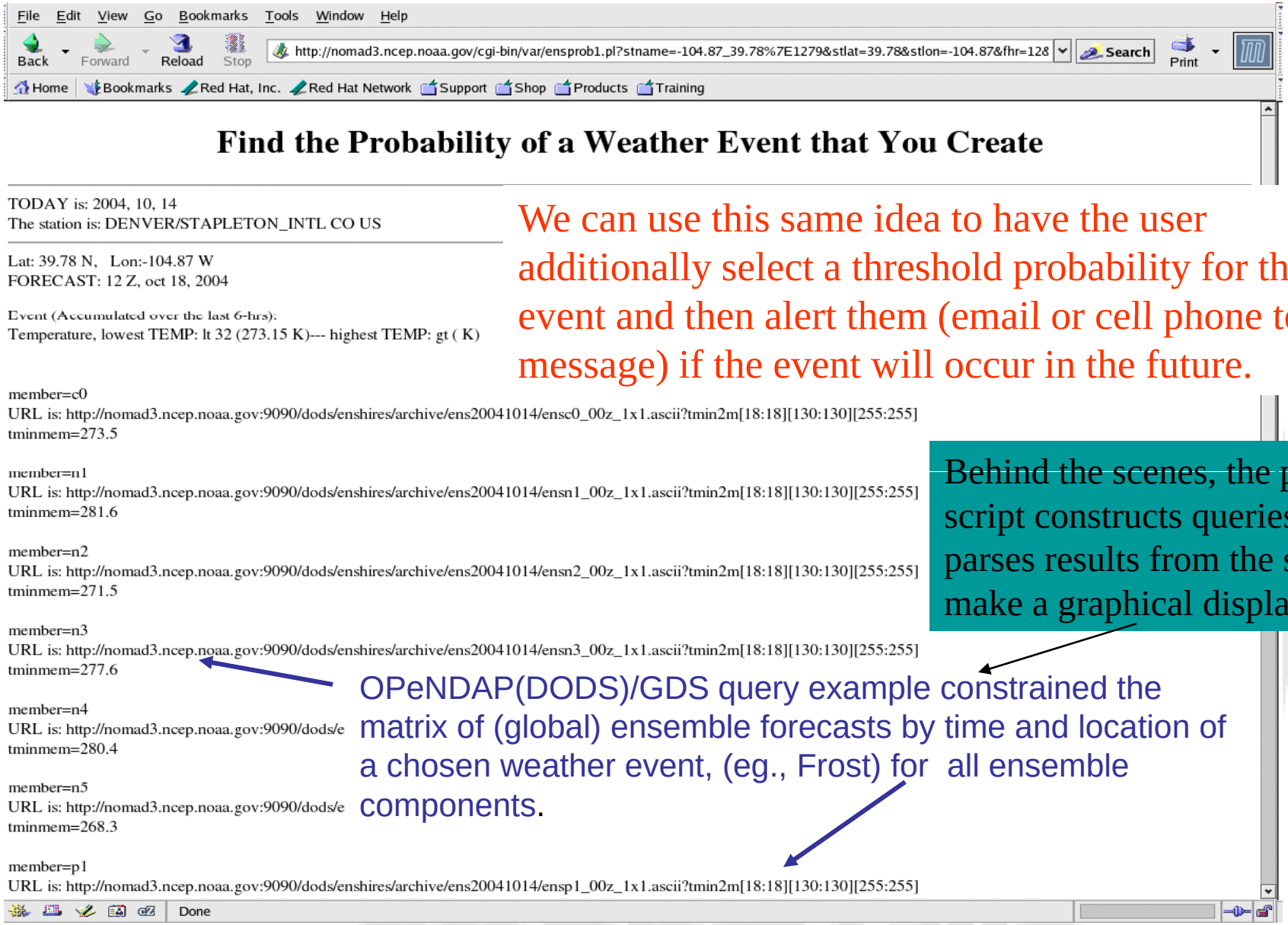
Global Ensembles and Event Probability Tool (see Alpert & Wang, 2005, AMS 21 IIPS 17.5,)

- NCEP ensembles are constructed from many (20) model integrations by changing the initial conditions.
- Ensembles attempt to span the space of possible forecasts and ensemble members are equally probable forecasts – if not, we can apply a suitable normalization.
- Probability estimates can be defined simply as the percentage of forecasts that satisfy a specified weather event over the total sample space (total number of components).
- We apply this to weather elements like surface temperature, wind speed, or precipitation at a location, at future model forecast times.

Screen shot of a web page containing prompts were users enter responses for defining the probability of a weather event that they choose.



One can try this at (http://nomads.ncdc.noaa.gov/EnsProb) or *http://nomad5.ncep.noaa.gov/cgi-bin/var/ensprob4.pl*

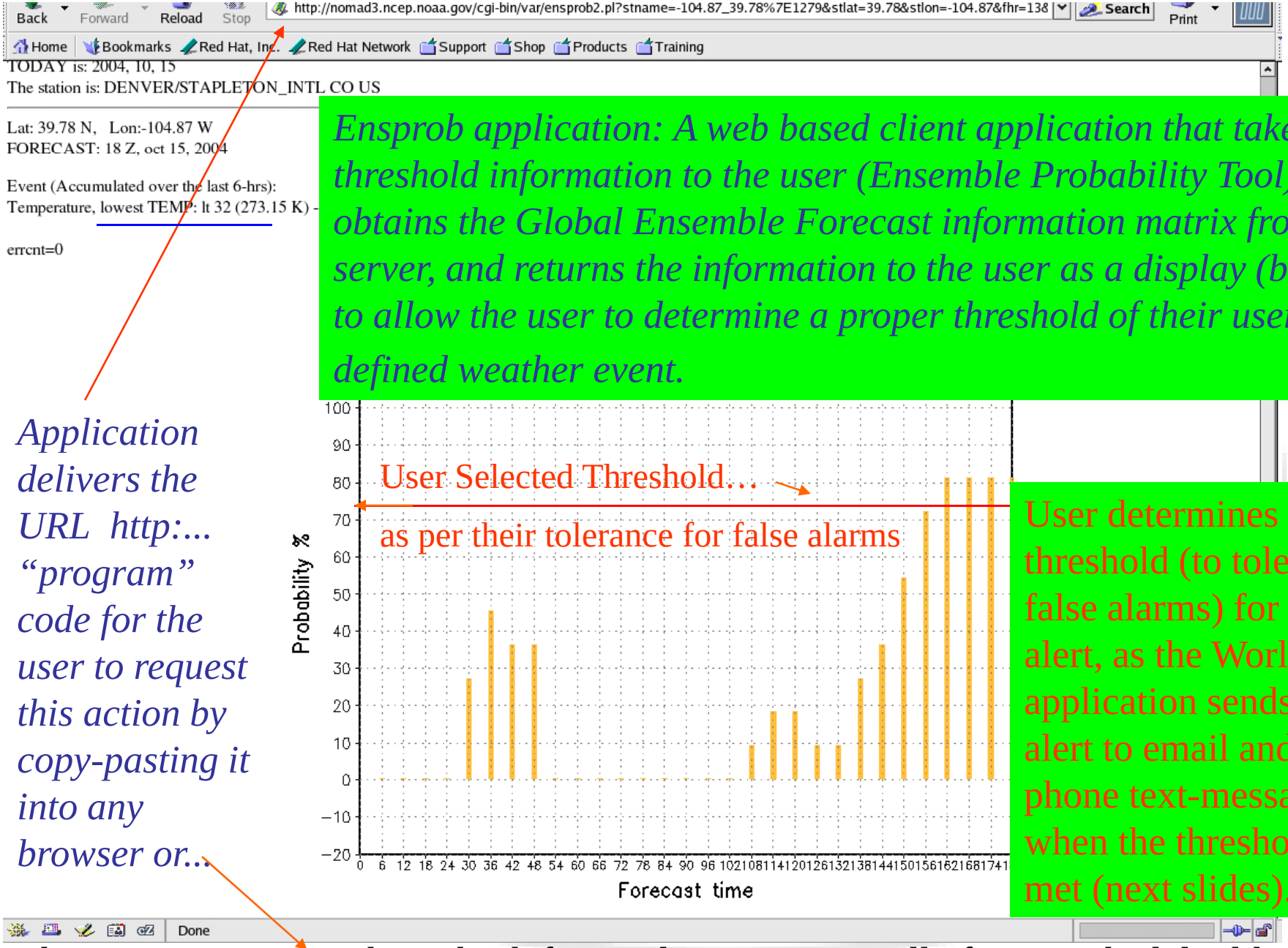


We can use this same idea to have the user additionally select a threshold probability for their event and then alert them (email or cell phone text message) if the event will occur in the future.

Behind the scenes, the program script constructs queries to and parses results from the server to make a graphical display…

OPeNDAP(DODS)/GDS query example constrained the matrix of (global) ensemble forecasts by time and location of a chosen weather event, (eg., Frost) for all ensemble components.

The Ensprob tool can be used to hone the probability threshold value for the users chosen event.



Ensprob application: A web based client application that takes threshold information to the user (Ensemble Probability Tool) , obtains the Global Ensemble Forecast information matrix from the server, and returns the information to the user as a display (below) to allow the user to determine a proper threshold of their user defined weather event.

Application delivers the URL http:... "program" code for the user to request this action by copy-pasting it into any browser or..

User determines their threshold (to tolerate false alarms) for an alert, as the Worldbank application sends an alert to email and cell phone text-message when the threshold is met (next slides).

The user can re-issue this "check for an alert" automatically from a scheduler like cron using a non-interactive web download command like "*wget*" with the returned URL.

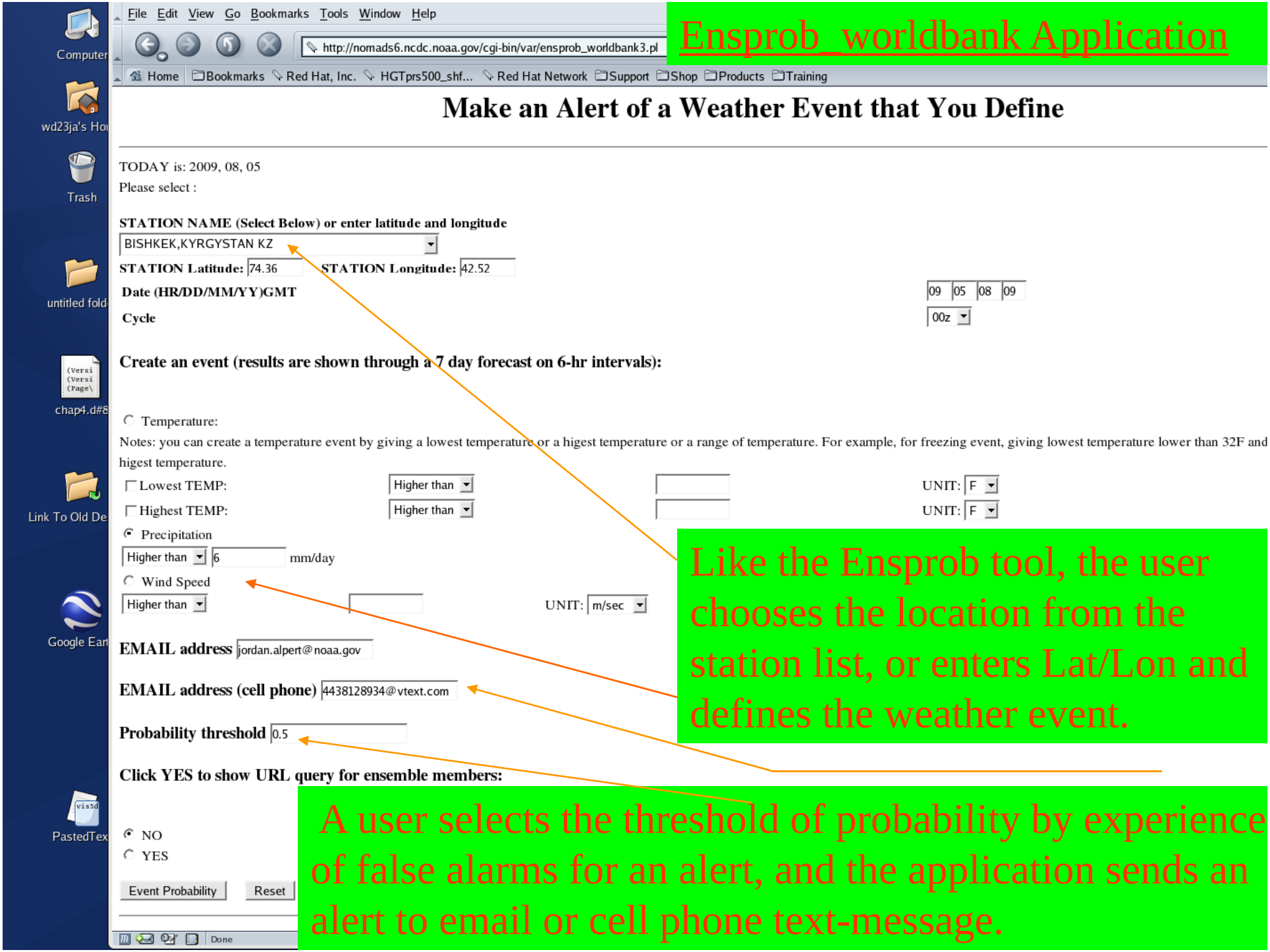
Weather Event Application Example Applied to a World Bank Study

The World Bank Working Paper No. 15 (2008), *"Weather and Climate Services in Europe and Central Asia, A Regional Review"*

Shows for Countries of Europe and Central Asia (ECA), eg., Kazakhstan, Kyrgyzstan Republic, etc…, the accuracy and value of available weather and climate services

"…are rising, bringing great economic benefits. However, many national hydrometeorological services (NMHSs) in Europe and Central Asia are in decline... Much more could be done to mitigate weather disasters, support the productivity of smallholding and commercial agriculture, conserve energy… Skillful forecasts of temperature, precipitation and wind conditions three to five days in advance are attainable and would greatly help farmers in the ECA region…[with the] *timing of fertilizer application and pest and disease control, mitigation of frost damage, enable farmers to take preventive measures against hail, or against erosion caused by wind/precipitation events, or to mitigate drought"*

At a June 2009 meeting of NOAA and World Bank representatives, it was agreed to take advantage of the increasing accuracy in weather prediction and the advances enabled by technology for weather event delivery to ECA countries where, perhaps, only a cell phone is available.


Ensprob_worldbank Application
File Edit View Go Bookmarks Tools Window Help
http://nomads6.ncdc.noaa.gov/cgi-bin/var/ensprob_worldbank3.pl
Home Bookmarks Red Hat, Inc. HGTprs500_shf... Red Hat Network Support Shop Products Training
Make an Alert of a Weather Event that You Define
TODAY is: 2009, 08, 05
Please select :
STATION NAME (Select Below) or enter latitude and longitude
BISHKEK,KYRGYSTAN KZ
STATION Latitude: 74.36 STATION Longitude: 42.52
Date (HR/DD/MM/YY)GMT 09 05 08 09
Cycle 00z
Create an event (results are shown through a 7 day forecast on 6-hr intervals):
Temperature:
Notes: you can create a temperature event by giving a lowest temperature or a higest temperature or a range of temperature. For example, for freezing event, giving lowest temperature lower than 32F and higest temperature.
Lowest TEMP: Higher than UNIT: F
Highest TEMP: Higher than UNIT: F
Precipitation
Higher than 6 mm/day
Wind Speed
Higher than UNIT: m/sec
EMAIL address jordan.alpert@noaa.gov
EMAIL address (cell phone) 4438128934@vtext.com
Probability threshold 0.5
Click YES to show URL query for ensemble members:
NO
YES
Event Probability Reset
Done
Like the Ensprob tool, the user chooses the location from the station list, or enters Lat/Lon and defines the weather event.
A user selects the threshold of probability by experience of false alarms for an alert, and the application sends an alert to email or cell phone text-message.

Results from the Worldbank application

- -------- Original Message --------
- Subject: ALERT WEATHER EVENT: Precip: gt 5 mm/day
- Date: Fri, 31 Jul 2009 16:01:39 -0400
- From: Apache <apache@noaa.gov>

- Precip: gt 5 mm/day > 50%, chance @ ft=
- 2009 aug 01 18Z
- 24 hr fcst

- (PLEASE DO NOT REPLY TO THIS EMAIL ADDRESS)

The user can copy-paste the final http://... URL address from this process and re-issue it from a scheduler like cron using a non-interactive web download command, "*wget*", to automatically repeat the 7-day scan for the alert with new data.

Accuracy of the GFS and therefore Ensemble accuracy continues to be a subject of study in the modeling community but as shown on the NCEP Ensemble web page:

http://www.emc.ncep.noaa.gov/gmb/targobs/target/ens/relpred.html

The probabilities assigned for example, for temperature, are within 15% and for precipitation a little more than 20%. This means that if a precipitation threshold of 100% is assigned, the verification may show an 80% probability.

As pointed out in Worldbank Rept 150, forecast accuracy continues to improve.

Summary

- NOAA Operational Model Archive and Distribution System (NOMADS) now high availability, 24/7, at the NOAA Web Operations Center (WOC)
- GRIB(2) filtering (ftp4/2u), Http (Fast or partial ftp), repackaging of grib files, scalable and distributive….
- OPeNDAP services using GrADS Data Server allowing that the …
- NCEP suite of model operational data in real time or archives are available so that the data appears as a local file.
- For example, Global Ensemble data matrix, is available across space, time including i^{th} component for all forecast times, variables, levels, Lat/Lon location with one server query, a 6D datacube.
- Users like the World Bank can obtain the data they need to make time critical decisions for their own projects
- Application examples are shown for users to construct probabilities from NCEP GFS (global) Ensemble matrix of data to obtain threshold information for alerts through email and cell phone text-messages

Future NOMADS

- Include high resolution operational model datasets eg., 4km NAMMB, T878 GFS, Ensembles as they are implemented
- BUFR files for Operational Conventional and non-conventional Observations served in a similar way to gridded fields
- NCEP Catalog servers, THREDDS/TDS
- Continue development with NCDC archive and NCEP real time model data and observations seamless access to promote useful applications
- The development web pages, ensprob and ensprob_worldbank can be applied to past forecasts archived on NOMADS servers such that the accuracy of the results can be verified.

NOMADS Servers for NCEP Model Data

(High availability Severs)

- http://nomads.ncep.noaa.gov (Data)
- http://nomads.ncdc.noaa.gov (Archives)

(NCEP Development)

- http://nomad1.ncep.noaa.gov (Data/Applications)
  http://nomad3.ncep.noaa.gov (Data/Applciations)
- http://nomad5.ncep.noaa.gov (Data/Applications)
- http://nomads6.ncdc.noaa.gov (Data/Applications)

Global ensemble probability display:
http://nomads6.ncdc.noaa.gov/cgi-bin/var/ensprob_worldbank3.pl

Global Ensemble probability event alert to a cell phone text-message :
http://nomads6.ncdc.noaa.gov/cgi-bin/var/ensprob_worldbank3.pl


NOMADS INSIDE